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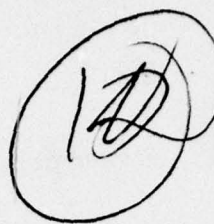
SPECIALIZED TRAINING VERSUS EXPERIENCE IN  
HELICOPTER NAVIGATION AT EXTREMELY LOW ALTITUDES

ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND  
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# **SPECIALIZED TRAINING VERSUS EXPERIENCE IN HELICOPTER NAVIGATION AT EXTREMELY LOW ALTITUDES**

John P. Farrell and Michael L. Fineberg

HUMAN FACTORS IN TACTICAL OPERATIONS TECHNICAL AREA



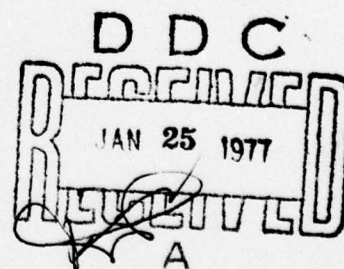
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## FOREWORD

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Within the Army Research Institute for the Behavioral and Social Sciences (ARI), the Human Factors in Tactical Operations Technical Area performs research to improve the performance of groups in a variety of military systems and operational units--in this case, the navigational performance of helicopter pilots flying at nap-of-the-earth (NOE) altitude (i.e., at or below treetop level).

While NOE flight requires a crew extremely competent in all procedural and manual flight skills, the principal problems are in low level navigation and orientation. The present Technical Paper reports a crucial early experiment on the importance of specific training for NOE navigation. Subsequent research has recently been reported in ARI Research Report 1190, "Aircrew Training Requirements for Nap-of-the-Earth Flight" and Research Problem Review 76-3, "Review of Flight Training Technology;" detailed aircrew task analyses are printed in ARI Research Memorandum 76-2 and a brief overview of ARI's NOE investigations in Research Memorandum 76-26. The entire research was guided and supervised by Dr. David Meister. The project was done in close cooperation with the Army Aviation School at Fort Rucker, Alabama; the contributions of military personnel there are gratefully acknowledged. Further research in human resources in aviation, including flight training selection, simulation, and NOE training, is being done by the ARI Field Unit at Fort Rucker.

The entire project is responsive to requirements of Army Project 2Q763743A772, "Aircrew Performance Enhancement in Tactical Operations," and to special requirements of the Deputy Chief of Staff for Operations and the U.S. Army Training and Doctrine Command.



J. E. BHLANER  
Technical Director

## **SPECIALIZED TRAINING VERSUS EXPERIENCE IN HELICOPTER NAVIGATION AT EXTREMELY LOW ALTITUDES**

### **BRIEF**

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#### **Requirement:**

To determine if the general navigation skills acquired in normal rotary-wing flight are transferable to very low altitude, nap-of-the-earth (NOE) flight.

#### **Procedure:**

Twenty-one Army helicopter pilots individually navigated at NOE altitude (at or below treetop level) on prescribed routes about 15 miles long, while a second helicopter at normal altitude recorded the actual path being flown. One group consisted of 14 instructor pilots having at least 2,000 hours experience, the other of 7 recent Aviation School graduates with 200 hours flight experience and a special 15-hour course in NOE navigation. Each pilot flew six different routes. They were judged on their ability to find the correct starting point and intermediate landing zones and to stay on course, and on their preflight planning.

#### **Findings:**

Mean scores for individuals were averaged to provide group scores. The only statistically significant difference between groups was that the experienced pilots were superior in flight planning. The novice pilots were slightly but not significantly superior on the NOE navigation measures of staying on course and identifying intermediate landing zones.

Either NOE navigation is a specific skill, to which normal flight experience does not transfer, or else the transfer of experienced pilots' navigational skill could be equaled by 15 hours of NOE navigation training.

#### **Utilization of findings:**

The need for and effectiveness of special training in NOE navigation has been confirmed by further extensive analyses which singled out problems in navigation and orientation as the major hazards of NOE flight. The results of these analyses have been validated by ARI's field research program, and the combined effort of analytical and field research used to develop the experimental Map Interpretation Terrain Analysis Course (MITAC) now under evaluation at the Army Aviation School.



## Specialized Training versus Experience in Helicopter Navigation at Extremely Low Altitudes

JOHN P. FARRELL and MICHAEL L. FINEBERG, *U. S. Army Research Institute for the Behavioral and Social Sciences, Arlington, Virginia*

*An experiment was performed to determine if navigation skills acquired in general helicopter flight transfer to extremely low levels and if the transfer could be matched by specialized training. Since the effects of extensive experience were matched by only 15 h of training, transfer may not be as extensive as generally assumed.*

### BACKGROUND

In recent years an increasing number of studies have dealt with pilot performance at very low altitudes. Some of these studies have been conducted with fixed wing aircraft; however, most have concerned rotary-wing aircraft (Aircrew Performance in Army Aviation, 1973). Low-level flight does have some application in civil aviation such as aerial crop dusting. However, the majority of studies have been in military aviation, because the development of this tactic is a direct response to the highly sophisticated air defense threats of potential enemies. The U. S. Army has developed very low-level flight into a tactic known as Nap-of-the-Earth (NOE) flight, i.e., flight at treetop level and below, using existing terrain features to mask the aircraft from radar and optical detection. This new style of flying will improve the chances of aircraft survival thereby increasing mission effectiveness and saving lives (Fineberg, 1974).

The introduction of NOE tactics presents special difficulties to Army rotary wing avi-

ators, primarily in navigation. The amount of terrain in the navigator's field of view is highly restricted because of his nearness to the ground, and, in addition, terrain features depicted on an aerial map appear in a much different perspective at NOE altitude. These factors interact to reduce the navigation effectiveness of aviators. Previous research by the Army Research Institute (ARI) quantified the amount of this reduction and indicated that the overall probability of mission success under NOE conditions was .57 (Fineberg, 1974). These results are in fairly close agreement with Canadian studies of aviator performance at very low levels (Lewis, 1961; Lewis, de la Riviere, and Sweeney, 1968).

The present experiment was designed to determine if the general navigation skills acquired in normal rotary-wing flight are transferable to the very low level flight, or NOE, situation. Since navigation presents a far more severe human factors problem than aircraft handling in NOE rotary wing flight, only navigation was tested in this experiment. The performance of instructor pilots

with extensive experience, a minimum of 2000 h of flight time, was compared to that of recent graduates of the Army Aviation School who had only 200 h of general flight experience and 15 h of specialized training in NOE navigation. It was hypothesized that if there were transfer of navigation skills acquired over a long period of time, the experienced pilots would be superior to the recent graduates on all measures used in the study. If there were little transfer of navigation skills and if NOE flight is indeed a situation different from traditional flight, the measures more specific to NOE should show little difference between recent graduates and experienced pilots. Obviously, if both extensive transfer took place and the specialized training were extremely effective, there would also be no difference between the experienced pilots and recent graduates. Such a result would still be an important finding since it would indicate that a short period of specialized training could be substituted for the effect of skills built up over several years of experience.

## METHOD

### *Subjects*

The subjects in this study were 21 Army pilots who were currently proficient in flying the UH-1H helicopter. One group consisted of 7 subjects who had recently graduated from aviation school where they had acquired 200 h of flight experience and had completed a new 15 h course on NOE navigation. The other group of 14 pilots were highly qualified instructor pilots who had a minimum of 2000 h of flight experience. This second group did have some experience flying at very low altitude in their current units and in Vietnam when conditions necessitated it, but they had not received specialized training in NOE navigation.

### *Test Terrain*

The test range used in all experiments lies just to the west of Troy, Alabama. The area is heavily wooded with numerous small fields and open areas. There are also many small streams and low-lying marsh areas throughout. The land itself is gently rolling terrain with few prominent landmarks which, by consensus of Army aviators, presents a very difficult NOE navigation problem. The length of the test routes ranged from 23 km to 25 km, and each pilot flew six different routes.

### *Aircraft*

Two UH-1H helicopters were employed in the study. The first, designated the "low ship," carried the subject/pilot, instructor/safety pilot, and the ARI test supervisor. The second aircraft was designated the "high ship" and served two purposes. It flew "chase" for safety reasons, and it provided the high-altitude (approximately 244 m) platform from which a second instructor pilot could track the flight of the low ship for experimental purposes. Each aircraft was equipped with armor seats, center jump seat, crashworthy fuel system, windscreen free of scratches, and a Lycoming 13B engine.

### *Test Personnel*

Four Army aviators were needed to conduct the tests. Two were highly qualified NOE instructor pilots who also served as technical advisors during design and implementation of these tests. The first instructor pilot flew the ship while the subject served as navigator. The second instructor pilot served as tracking observer in the high ship. His task was to follow the flight of the low ship and trace its progress on a map in relation to the prescribed course previously drawn. The remain-



ing Army aviators alternated in flying the high ship.

#### *Procedure*

Each subject pilot navigated at the altitude of 244 m from the point of hover check to the starting point of the NOE route, with the high ship flying chase. Identification of the Start Point by the subject was scored by the instructor pilot as correct or incorrect.

The subject pilot then began navigating the test route at NOE altitude and attempted to follow the prescribed course on his map as accurately as possible. The actual course flown by the subject was concurrently being drawn on the duplicate map by the high-ship observer. Each of the 21 subjects navigated on 6 flights for a total of 126 flights. Routes were selected so that subjects never flew over the same route twice.

During the mission the subject was required to maintain his course within a 500-m corridor. He was scored in error if he deviated more than 250 m to either side of the course line. The subject was also required to identify and stop at each intermediate landing zone. His selection of each landing zone was scored by the instructor pilot as correct if he had landed within 100 m of the correct landing zone. After the debriefing, the ARI test supervisor retained the high-ship observer's map. Four indices of pilot navigation performance were used in the study. Those

measures more related to NOE performance were the percent of the NOE route flown off course by 250 m or more and the objective mission success score (OMSS). The OMSS is a composite score based on the number and distance of excursions from the planned route and ability to find designated landing zones en route (Fineberg, 1974). The last two measures, the ability to find the start of the NOE route from traditional altitude and flight planning, were measures related more to general aviation experience.

#### RESULTS

Arithmetic means across all six flights were calculated for each subject. These data were used to calculate the group means on each of the four dependent variables. The arithmetic means across the six flights for each subject were ranked to compare the two experimental groups using the Mann Whitney U test (Siegel, 1956). The results of these comparisons are presented in Table 1. The only significant difference ( $p < .05$ ) is on the flight planning measure where the highly experienced pilots are superior to the recent graduates. The differences yielded by the other three measures did not approach traditional levels of significance ( $p > .05$ ) which tends to support the hypothesis.

#### DISCUSSION

It was expected that the 2000-h pilots

TABLE 1

Comparison of Recent NOE Graduates with Experienced Pilots

| Measure                         | Experienced Pilots | Recent Graduates | Mann Whitney U | p   |
|---------------------------------|--------------------|------------------|----------------|-----|
| Percent Initial Points Found    | 94.10              | 90.40            | 60             | .20 |
| Percent Off Course              | 15.40              | 12.80            | 45             | .39 |
| Objective Mission Success Score | .65                | .70              | 56             | .30 |
| Flight Planning                 | 2.70               | 2.40             | 70             | .05 |

would be generally superior to the recent aviation school graduates who had only 200 h of flight experience. If this did not occur it would indicate that either the required skills were not the same in normal and in NOE navigation or that any transfer the experienced pilots had could be equaled by only 15 h of specialized training in NOE. Examination of the results in Table 1 show that the only significant difference between the groups ( $p < .05$ ) occurred on the flight planning measure which is more related to general flying and not to NOE specifically.

On those measures specific to the NOE navigation situation, *i.e.*, percent distance flown off course and the OMSS, the alpha levels were .39 and .30, respectively. It should again be noted that the pilots were only compared on navigation performance and not on psychomotor skills or aircraft handling. Since there were no significant differences between the recent aviation school graduates and the highly experienced pilots on those measures specific to the NOE situation two conclusions are possible: (1) NOE navigation is a specific skill, and there was no transfer; or (2) there was transfer, but it was offset by the effectiveness of the 15 h of specialized instruction

in NOE. In either case a very short period of specialized training resulted in performance equivalent to a group with very extensive experience. A broad general implication is that skill transfer from one situation to another may not be as extensive as expected, and short periods of specialized training may be more effective than generally recognized.

#### ACKNOWLEDGMENTS

This experiment was conducted by the Army Research Institute for the Behavioral and Social Sciences (ARI) at Ft. Rucker, Alabama, with the cooperation of the Army Aviation Center. The views expressed in this paper are those of the authors and not necessarily those of the U. S. Army Research Institute for the Behavioral and Social Sciences.

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